PAT-NO: JP405313066A

DOCUMENT-IDENTIFIER: JP 05313066 A

TITLE: ZOOM LENS

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PURPOSE: To provide a zoom lens having a wide angle of view and a high variable power ratio by arranging five lens groups as a whole, and setting moving conditions of respective lens groups properly according to refracting powers or variable powers of the respective lens groups.

CONSTITUTION: Five lens groups of the first group L1 having a negative refracting power, the second group L2 having a negative refracting power, the third group L3 having a positive refracting power, the fourth group L4 having a negative refracting power and the fifth group L5 having a positive refracting power are arranged in this order from the object side, and when a power variation is carried out from a wide angle end to a telescopic end, at least the first L1, the second L2, the third L3 and the fifth group L5 are moved so that a distance between the second group L2 and the third group L3 is decreased and a distance between the third group L3 and the fourth group L4 is increased and a distance between the fourth group L4 and the fifth group L5 is decreased, and the first group L1 and the second group L2 are moved on different loci.

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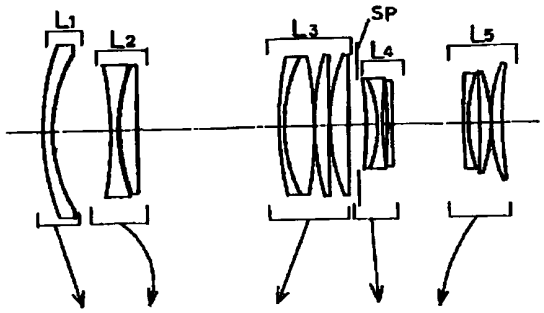
(54)【発明の名称】　ズームレンズ

(57)【要約】
【目的】　全体として５つのレンズ群を有し、各レンズ群の屈折力や変倍に伴う各レンズ群の移動条件を適切に設定し、広画角でしかも高変倍比のズームレンズを得ること。
【構成】　物体側より順に負の屈折力の第１群、負の屈折力の第２群、正の屈折力の第３群、負の屈折力の第４群そして正の屈折力の第５群の５つのレンズ群を有し、広角端から望遠端への変倍に際して該第２群と第３群との間隔を減少させ、該第３群と第４群との間隔を増大させ、該第４群と第５群との間隔を減少させるように少なくとも該第１，第２，第３，第５群を移動させると共に該第１群と第２群とを異なった軌跡で移動させたこと。



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【特許請求の範囲】

【請求項1】　物体側より順に負の屈折力の第1群、負の屈折力の第2群、正の屈折力の第3群、負の屈折力の第4群そして正の屈折力の第5群の5つのレンズ群を有し、広角端から望遠端への変倍に際して該第2群と第3群との間隔を減少させ、該第3群と第4群との間隔を増大させ、該第4群と第5群との間隔を減少させるように少なくとも該第1，第2，第3，第5群を移動させると共に該第1群と第2群とを異った軌跡で移動させたことを特徴とするズームレンズ。

【請求項2】　前記第1群は変倍に際して一方向に移動していることを特徴とする請求項1のズームレンズ。

【請求項3】　前記第2群を移動させてフォーカスを行なっていることを特徴とする請求項1のズームレンズ。

【請求項4】　前記第2群は像面側に凹面を向けた負の第21レンズと物体側に凸面を向けた正の第22レンズとを有しており、該第21レンズの像面側のレンズ面の曲率半径をR2a、該第22レンズの物体側のレンズ面の曲率半径をR2b、前記第i群の焦点距離をfi、広角端における前記第1群と第2群の合成の焦点距離をf1，2、望遠端における全系の焦点距離をfTとしたとき

0．35<|f1，2|／fT<0．9

0．75<f1／f2<3．0

0．7　<R2a／R2b<1．2

なる条件を満足することを特徴とする請求項1のズームレンズ。

【請求項5】　前記第3群は少なくとも1枚の負レンズと少なくとも2枚の正レンズを有しており、該第3群の焦点距離をf3、望遠端における全系の焦点距離をfTとしたとき

0．28<f3／fT<0．85

なる条件を満足することを特徴とする請求項1のズームレンズ。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は35mmフィルム用の写真用カメラや電子記録用のビデオカメラそしてSVカメラ等に好適なズームレンズに関し、特に負の屈折力のレンズ群が先行する全体として5つのレンズ群を有し、これら5つのレンズ群の変倍に伴う移動条件や各レンズ群の屈折力やレンズ構成等を適切に設定することにより全変倍範囲にわたり高い光学性能を有した広画角域を含むズームレンズに関するものである。

【0002】

【従来の技術】従来より負の屈折力のレンズ群が先行する所謂ネガティブリード型のズームレンズは広画角化が比較的容易である為、広画角用のズームレンズに多く用いられている。例えば特公昭49－23912号公報や特開昭57－163213号公報等では物体側より順に

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負の屈折力の第1群、正の屈折力の第2群、負の屈折力の第3群そして正の屈折力の第4群の4つのレンズ群を有し、広角端から望遠端への変倍に際して、第1群を像面側へ移動させ、第2群と第4群を物体側へ移動させ、第3群を固定若しくは移動させたズームレンズが提案されている。

【0003】このような負の屈折力のレンズ群が先行するネガティブリード型のズームレンズは比較的広画角化が容易で、かつ近接撮影距離が短くなる等の特徴を有している。

【0004】しかしながら高変倍化を図りつつ、レンズ系全体の小型化を図る為に各レンズ群の屈折力を強めると諸収差の発生が多くなり光学性能が大きく劣化してくる。又大口径化を図ろうとすると絞り径が増大し、レンズ系全体が大型化してくるという問題点が生じてくる。

【0005】これらの欠点を改善し、レンズ系全体の小型化及び高変倍化を図ったズームレンズが例えば特公昭55－14403号公報、特開昭63－241511号公報特開平1－193709号公報等で提案されている。

【0006】これらの各公報ではズームレンズを物体側より順に負、正、負、そして正の屈折力のレンズ群の全体として4つのレンズ群より構成し、このうち所定のレンズ群を適切に移動させて変倍を行っている。

【0007】この他、特開平2－201310号公報では同様の構成のズームレンズにおいて第1群中の比較的軽量の一部のレンズ群を光軸上移動させてフォーカスを行い、例えばオートフォーカスを行う際のフォーカス操作を容易にしたズームレンズを提案している。

【0008】

【発明が解決しようとする課題】近年一眼レフカメラやビデオカメラ等に用いる標準用のズームレンズとしては広画角を含み、かつ高変倍比のものが要望されている。例えば既に35mmフィルム用の一眼レフカメラでは焦点距離35mm～70mm程度の広画角のズームレンズが標準用のズームレンズとして用いられている。

【0009】一般にこの程度の撮影画角でしかもFナンバー2．8程度の口径比を確保しようとするとレンズ構成が複雑になり全変倍範囲にわたり光学性能を良好に補正するのが難しくなってくる。又、一般にこのようなズームレンズでは物体側の第1群のレンズ外径が大きく又高重量である場合が多い。

【0010】この為、例えばオートフォーカス等の電動でフォーカスを行うパワーフォーカス方式のカメラでは高重量の第1群をフォーカスに際して移動させると大型のモーター等の駆動手段を必要とし、又消費電力及びスペース等の点でカメラ全体が大型化してくるという問題点がある。

【0011】本発明はズームレンズを全体として5つのレンズ群より構成し、各レンズ群の屈折力や変倍に伴う

各レンズ群の移動条件等を適切に設定することにより、レンズ全長を短縮し、大口径比でしかも比較的広画角で全変倍範囲にわたり高い光学性能を有したズームレンズの提供を目的とする。

【００１２】この他、本発明では第１群以外のレンズ群でフォーカスを行うインナーフォーカス方式を採用し、フォーカス操作がしやすい例えばオートフォーカスカメラ等に好適な広画角のズームレンズの提供を目的とする。

【００１３】

【課題を解決するための手段】本発明のズームレンズは物体側より順に負の屈折力の第１群、負の屈折力の第２群、正の屈折力の第３群、負の屈折力の第４群そして正の屈折力の第５群の５つのレンズ群を有し、広角端から望遠端への変倍に際して該第２群と第３群との間隔を減少させ、該第３群と第４群との間隔を増大させ、該第４群と第５群との間隔を減少させるように少なくとも該第１，第２，第３，第５群を移動させると共に該第１群と第２群とを異なった軌跡で移動させたことを特徴としている。

【００１４】特に本発明では第１群は変倍に際して一方向に移動していることや第２群を移動させてフォーカスを行っていること等を特徴としている。

【００１５】

【実施例】図１～図３は本発明の数値実施例１～３の広角端におけるレンズ断面図である。

【００１６】図中Ｌ１は負の屈折力の第１群、Ｌ２は負の屈折力の第２群、Ｌ３は正の屈折力の第３群、Ｌ４は負の屈折力の第４群、Ｌ５は正の屈折力の第５群である。ＳＰは絞りである。矢印は広角端から望遠端への変倍を行う際の各レンズ群の移動軌跡を示している。

【００１７】本実施例では図に示すように広角端から望遠端への変倍に際しては第２群と第３群との間隔を減少させ、第３群と第４群との間隔を増大させ、第４群と第５群との間隔を減少させるように所定のレンズ群を移動させると共に第１群と第２群とを互いに異なった軌跡で移動させている。

【００１８】このうち図１の数値実施例１では５つのレンズ群全てを移動させている。図２，図３の数値実施例２，３では第１，第２，第３，第５群を移動させて第４群を固定としている。又図１～図３の各実施例において、フォーカスは第２群を移動させて行っている。

【００１９】本発明のズームレンズは広角端において共に負の屈折力の第１群と第２群に対して正の屈折力の第３群を光軸上隔てて（遠く離して）配置し、又第３群に対して負の屈折力の第４群を接近して配置し更に第４群に対して正の屈折力の第５群を隔てて配置している。これによりレンズ系全体がレトロ型のレンズ構成となるようにして広画角化を図りつつ所定のバックフォーカスが容易に得られるようにしている。

【００２０】そして広角端から望遠端への変倍に際しては望遠端において共に負の屈折力の第１群と第２群に対して正の屈折力の第３群が接近するようにし、第３群と負の屈折力の第４群との間隔が広くなるようにし、第４群に対して正の屈折力の第５群が接近するように所定のレンズ群を移動させて変倍を行ってレンズ系全体が望遠型（テレタイプ）のレンズ構成となるようにしている。

【００２１】これにより各レンズ群に変倍を効果的に分担させ、変倍の際の各レンズ群の移動量を減少させて、所定の変倍比を確保しつつレンズ系全体の小型化を図っている。

【００２２】図１の数値実施例１では広角端から望遠端への変倍に際し、第１群と第４群とを直線的に像面側へ移動させ、第３群を直線的に物体側へ移動させ、第５群を物体側へ凸状の軌跡を有するように移動させ、第２群を像面側へ凸状の軌跡を有するように移動している。尚図２，図３の数値実施例２，３では第４群は固定であり、第５群は物体側へ直線的に移動し、他のレンズ群は数値実施例１と同じである。

【００２３】本発明ではこのとき第１群が変倍に際して急激に移動速度が変化したり、変倍の途中で移動方向が逆転しないようにして、例えばカメラの光軸方向への衝撃に対して強いレンズ鏡筒の構成を可能としている。

【００２４】特に第１群を直線的に移動させて、カメラへの衝撃に対して強化すると共にレンズ鏡筒構造上もカム溝を不要とし、レンズ鏡筒構造の簡素化を図っている。又フォーカスを比較的レンズ重量の軽い第２群を光軸上移動させて行なう、所謂インナーフォーカス方式を用いることにより、例えばオートフフォーカスカメラに適用したときのフォーカス操作を容易にし高速のフォーカス操作を可能としている。

【００２５】更にこのようなインナーフォーカス方式を採用することにより変倍及びフォーカスの際に第１群が回転しないレンズ鏡筒の構造を可能とし、かつ構成上の簡素化を容易にしている。

【００２６】本発明のズームレンズでは第１群に像面側に強い屈折力の凹面を向けたメニスカス状の負レンズを有するように構成している。これにより軸外光束を徐々に屈折させて広角端においてレンズ系全体のレトロ型化を容易にし、広画角化を図ったときに発生する広角側での負の歪曲収差を良好に補正している。

【００２７】尚、本発明においてレンズ全長の短縮化及び広画角化を図りつつ全変倍範囲にわたり収差変動が少なく高い光学性能を得るには次の諸条件を満足させるのが良い。

【００２８】前記第２群は像面側に凹面を向けた負の第２１レンズと物体側に凸面を向けた正の第２２レンズとを有しており、該第２１レンズの像面側のレンズ面の曲率半径をＲ２ａ、該第２２レンズの物体側のレンズ面の曲率半径をＲ２ｂ、前記第ｉ群の焦点距離をｆｉ、広角

端における前記第１群と第２群の合成の焦点距離をｆ　　＊き
１，２、望遠端における全系の焦点距離をｆＴとしたと＊

$$0.35<|f1,2|/fT<0.9 \quad \cdots\cdots(1)$$
$$0.75<f1/f2<3.0 \quad \cdots\cdots(2)$$
$$0.7 <R2a/R2b<1.2 \quad \cdots\cdots(3)$$

なる条件を満足することである。

【００２９】条件式（１）は広角端における第１群と第２群の合成の屈折力を適切に設定し、主にレンズ外径の縮小化を図りつつ、諸収差をバランスク良く補正する為のものである。

【００３０】条件式（１）の上限値を越えて第１群と第２群の合成の屈折力が弱くなりすぎると広角側において軸外光束の屈折作用が弱くなり、所定量の軸外光束を確保する為に第１群と第２群のレンズ外径を大きくしなければならなくなってくる。又下限値を越えて第１群と第２群の合成の屈折力が強くなりすぎると第１群と第２群のレンズ外径は小さくなるが第１群と第２群で発生する歪曲収差や非点収差等の軸外収差が大きくなり、これらの諸収差を他のレンズ群で補正するのが難しくなってくる。

【００３１】条件式（２）は条件式（１）の基で第１群と第２群の屈折力の比を適切に設定し、主にレンズ全長の短縮化を図りつつ、第２群でフォーカスする際の収差変動を少なくする為のものである。

【００３２】条件式（２）の上限値を越えて第２群の屈折力が強くなりすぎると第２群でフォーカスするときの移動量は小さくなり、レンズ全長の短縮化には有利であるが、フォーカスの際の収差変動量が大きくなり、物体距離全般にわたり光学性能を良好に保つのが難しくなってくる。又下限値を越えて第２群の屈折力が弱くなりすぎるとフォーカスの際の移動量が増大し、レンズ全長が※

$$0.28<f3/fT<0.85$$

なる条件を満足することである。

【００３８】条件式（４）は望遠端における全系の焦点距離に対する第３群の焦点距離の比に関するものである。

【００３９】条件式（４）の上限値を越えて第３群の屈折力が弱くなりすぎると所定の変倍比を確保する為の変倍に伴なう各レンズ群の移動量が増大し、レンズ全長が長くなると共にレンズ外径も増大してくるので良くない。又下限値を越えて第３群の屈折力が強くなりすぎるとレンズ系全体は小型になるが第３群から球面収差等の諸収差の発生が多くなり、これを他のレンズ群で補正するのが難しくなってくる。

【００４０】本発明では条件式（４）を満足すると共に第３群を少なくとも１枚の負レンズと少なくとも２枚の★

※長くなると共に第１群と絞りとの間隔が長くなり、軸外光束を確保する為の第１群のレンズ外径が増大してくるので良くない。

【００３３】条件式（３）は第２群を構成する負の第２１レンズの像面側のレンズ面の曲率半径Ｒａと正の第２２レンズの物体側のレンズ面の曲率半径Ｒｂとの比を適切に設定し、主に第１群で発生する球面収差を良好に補正する為のものである。

【００３４】条件式（３）の上限値を越えて曲率半径Ｒ２ａが曲率半径Ｒ２ｂに比べて大きくなりすぎると球面収差は良好に補正されるが第２群全体の負の屈折力が弱まり、これを他のレンズ面で負担すると該レンズ面よりコマ収差等の諸収差の発生量が多くなってくる。

【００３５】又、下限値を越えて曲率半径Ｒ２ａが曲率半径Ｒ２ｂに比べて小さくなりすぎると正の球面収差の発生量が多くなり、これを他のレンズ面で例えば第２２レンズの物体側のレンズ面で補正するのが難しくなってくる。

【００３６】この他、本発明において所定の変倍比を確保しつつ全変倍範囲にわたり諸収差をバランス良く補正するには次の条件を満足させるのが良い。

【００３７】前記第３群は少なくとも１枚の負レンズと少なくとも２枚の正レンズを有しており、該第３群の焦点距離をｆ３、望遠端における全系の焦点距離をｆＴとしたとき

$$\cdots\cdots(4)$$

★正レンズを有するように構成し、これにより色収差を良好に補正すると共に球面収差の発生量を少なくしている。

【００４１】次に本発明の数値実施例を示す。数値実施例においてＲｉは物体側より順に第ｉ番目のレンズ面の曲率半径、Ｄｉは物体側より第ｉ番目のレンズ厚及び空気間隔、Ｎｉとνｉは各々物体側より順に第ｉ番目のレンズのガラスの屈折率とアッベ数である。

【００４２】非球面形状は光軸方向にＸ軸、光軸と垂直方向にＨ軸、光の進行方向を正としＲを近軸曲率半径、Ａ，Ｂ，Ｃ，Ｄ，Ｅを各々非球面係数としたとき

【００４３】

【数１】

$$X=\frac{(1/R)H^2}{1+\sqrt{1-(H/R)^2}}+AH^2+BH^4+CH^6+DH^8+EH^{10}$$

7　　8

なる式で表わしている。又前述の各条件式と数値実施例における諸数値との関係を表－1に示す。

＊数値実施例 1

＊

F=36.5 ～77.4　FNO=1:2.9　2ω= 62.2° ～31.1°
R 1= 69.33　D 1= 2.20　N 1=1.77250　ν 1= 49.6
(非球面) - ASPHERIC.
R 2= 38.49　D 2= 可変
R 3= -79.11　D 3= 1.80　N 2=1.88300　ν 2= 40.8
R 4= 54.47　D 4= 0.50
R 5= 56.11　D 5= 4.50　N 3=1.84666　ν 3= 23.8
R 6= 5045.30　D 6= 可変
R 7= 89.26　D 7= 1.50　N 4=1.84666　ν 4= 23.8
R 8= 37.81　D 8= 8.00　N 5=1.65160　ν 5= 58.5
R 9= -103.33　D 9= 0.15
R10= 74.97　D10= 4.00　N 6=1.69680　ν 6= 55.5
R11= 1307.60　D11= 0.15
R12= 51.67　D12= 5.00　N 7=1.69680　ν 7= 55.5
R13= 3317.12　D13= 可変
R14= (絞り)　D14= 2.00
R15= -93.73　D15= 3.30　N 8=1.80518　ν 8= 25.4
R16= -31.23　D16= 1.30　N 9=1.63930　ν 9= 44.9
R17= 77.19　D17= 1.40
R18= -162.57　D18= 1.30　N10=1.60323　ν10= 42.3
R19=-7621.93　D19= 可変
R20= 245.95　D20= 1.30　N11=1.84666　ν11= 23.8
R21= 35.85　D21= 2.70
R22= 871.81　D22= 3.00　N12=1.69680　ν12= 55.5
R23= -46.11　D23= 0.15
R24= 41.75　D24= 2.80　N13=1.77250　ν13= 49.6
R25= 81.22

非球面系数　ASPHERICAL COEFFICIENTS.
B＝2．01734×10^{-7}　　C＝ 1．45657×10^{-10}
D＝6．76429×10^{-14}　　E＝－3．01424×10^{-16}

※数値実施例 2

【0044】
【表1】

焦点距離 可変間隔	36．52	77．42
D 2	16．43	15．33
D 6	37．63	0．99
D13	2．64	19．64
D19	18．93	1．93

40

※

F=35.9 ～77.8　FNO=1:2.9　2ω= 62.2° ～31.1°
R 1= 684.66　D 1= 2.62　N 1=1.80518　ν 1= 25.4
R 2=-1055.76　D 2= 0.20
R 3= 149.76　D 3= 2.10　N 2=1.71300　ν 2= 53.8
R 4= 53.30　D 4= 可変
R 5= -488.25　D 5= 2.00　N 3=1.77250　ν 3= 49.6

9　　10

R 6=　44.81　D 6=　0.53
R 7=　43.27　D 7=　3.50　N 4=1.84666　ν 4= 23.9
R 8=　78.34　D 8= 可変
R 9=　84.43　D 9=　1.20　N 5=1.84666　ν 5= 23.8
R10=　30.98　D10=　7.20　N 6=1.55963　ν 6= 61.2
R11=-1529.08　D11=　0.15
R12=　50.67　D12=　6.00　N 7=1.65160　ν 7= 58.5
R13= -110.42　D13=　0.15
R14=　40.57　D14=　3.30　N 8=1.65160　ν 8= 58.5
R15=　71.98　D15= 可変
R16= (絞り)　D16=　1.50
R17= -145.10　D17=　3.00　N 9=1.84666　ν 9= 23.8
R18=　-34.13　D18=　1.20　N10=1.60311　ν10= 60.7
R19=　112.83　D19=　2.00
R20=　-42.83　D20=　1.40　N11=1.60311　ν11= 60.7
R21=　66.44　D21= 可変
R22=　347.07　D22=　5.00　N12=1.55963　ν12= 61.2
R23=　-26.27　D23=　1.50　N13=1.80518　ν13= 25.4
R24=　-35.22　D24=　0.15
R25=　104.39　D25=　5.00　N14=1.71300　ν14= 53.8
R26=　-51.25　D26=　5.44
R27=　-30.94　D27=　1.35　N15=1.84666　ν15= 23.8
R28=　-84.63

【表2】

焦点距離 可変間隔	35.91	77.79
D 4	18.02	17.94
D 8	40.13	2.52
D15	6.91	21.23
D21	13.17	2.94

＊数値実施例 3

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＊

F=35.8 ～77.6　FNO=1:2.9　2ω= 62.3° ～31.2°
R 1=　791.76　D 1=　2.62　N 1=1.80518　ν 1= 25.4
R 2　-1937.16　D 2=　0.20
R 3=　112.86　D 3=　2.10　N 2=1.71300　ν 2= 53.8
R 4=　51.40　D 4= 可変
R 5=　-317.21　D 5=　2.00　N 3=1.77250　ν 3= 49.6
R 6=　44.52　D 6=　0.60
R 7=　43.29　D 7=　3.50　N 4=1.84666　ν 4= 23.9
R 8=　75.72　D 8= 可変
R 9=　78.89　D 9=　1.20　N 5=1.84666　ν 5= 23.8
R10=　31.34　D10=　7.20　N 6=1.55963　ν 6= 61.2
R11=-78204.10　D11=　0.15
R12=　52.30　D12=　6.00　N 7=1.65160　ν 7= 58.5
R13=　-104.66　D13=　0.15
R14=　43.06　D14=　3.30　N 8=1.65160　ν 8= 58.5
R15=　95.40　D15= 可変

R16=（絞り）　D16= 1.50
R17= -134.01　D17= 3.00　N 9=1.84666　ν 9= 23.8
R18= -33.45　D18= 1.20　N10=1.60311　ν10= 60.7
R19= 102.01　D19= 2.00
R20= -44.08　D20= 1.40　N11=1.60311　ν11= 60.7
R21= 63.77　D21= 可変
R22= 723.38　D22= 5.30　N12=1.55963　ν12= 61.2
R23= -26.94　D23= 1.50　N13=1.80518　ν13= 25.4
R24= -31.98　D24= 0.15
R25= 97.49　D25= 5.00　N14=1.71300　ν14= 53.8
R26= -48.30　D26= 2.50
R27= -32.10　D27= 1.35　N15=1.84666　ν15= 23.8
R28= -125.97

【表3】

焦点距離 可変間隔	35.80	54.93	77.64
D 4	18.26	22.67	17.75
D 8	39.45	13.78	2.44
D15	7.07	14.07	21.07
D21	13.17	8.09	3.01

【0045】

＊　＊【表4】

表 － 1

条件式	数値実施例		
	1	2	3
(1) |f1,2|／fT	0.576	0.897	0.693
(2) f1／f2	1.418	1.522	1.897
(3) R2a／R2b	0.971	1.036	1.028
(4) f3／fT	0.413	0.483	0.461

【0046】

【発明の効果】本発明によれば前述の如く５つのレンズ群の屈折力や変倍に伴う各レンズ群の移動条件等を特定することにより、レンズ全長を短縮し、かつレンズ鏡筒構造を簡素にしつつ、比較的広画角でしかも高変倍比の全変倍範囲にわたり高い光学性能を有したズームレンズを達成することができる。

【図面の簡単な説明】

【図１】　本発明の数値実施例１のレンズ断面図
【図２】　本発明の数値実施例２のレンズ断面図
【図３】　本発明の数値実施例３のレンズ断面図
【図４】　本発明の数値実施例１の広角端のズーム位置における諸収差図
【図５】　本発明の数値実施例１の中間のズーム位置に※おける諸収差図
【図６】　本発明の数値実施例１の望遠端のズーム位置における諸収差図
【図７】　本発明の数値実施例２の広角端のズーム位置における諸収差図
【図８】　本発明の数値実施例２の中間のズーム位置における諸収差図
【図９】　本発明の数値実施例２の望遠端のズーム位置における諸収差図
【図１０】　本発明の数値実施例３の広角端のズーム位置における諸収差図
【図１１】　本発明の数値実施例３の中間のズーム位置における諸収差図
【図１２】　本発明の数値実施例３の望遠端のズーム位

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置における諸収差図

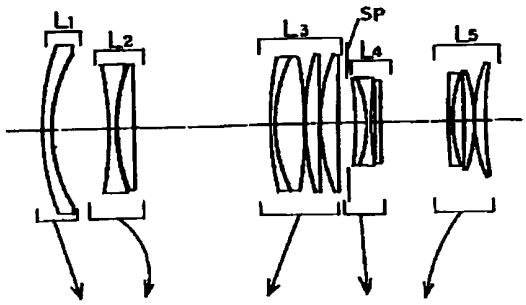
【符号の説明】

L1　第1群
L2　第2群
L3　第3群
L4　第4群

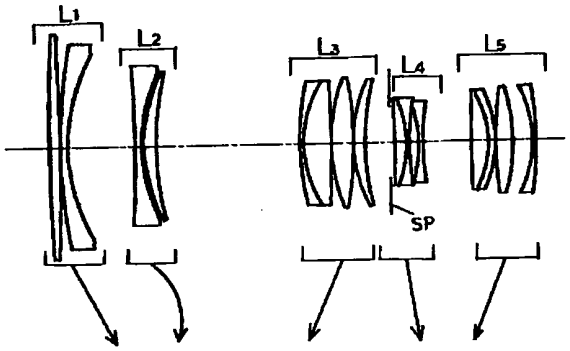
14

L5　第5群
SP　絞り
S　サジタル像面
M　メリディオナル像面
d　d線
g　g線

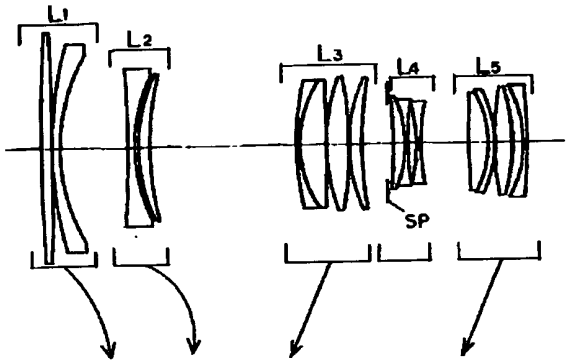
【図1】



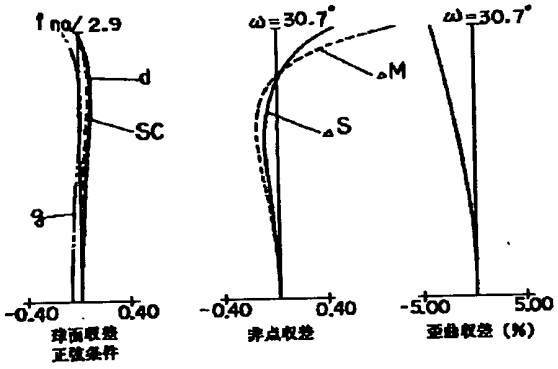
【図2】



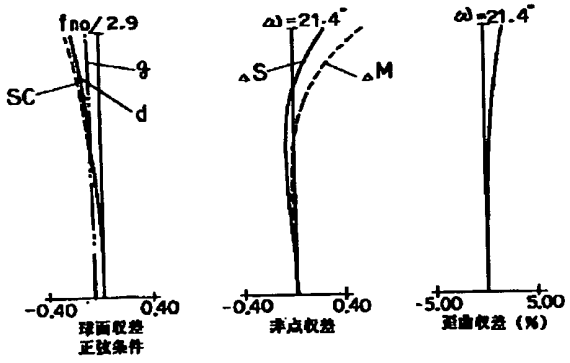
【図3】



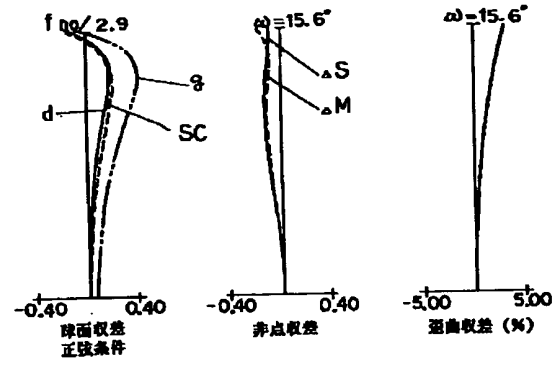
【図4】



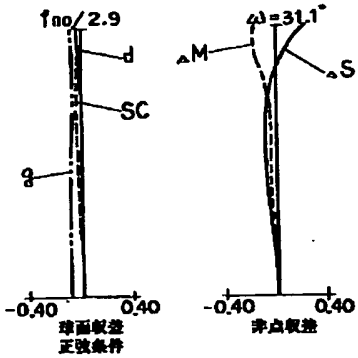
【図5】



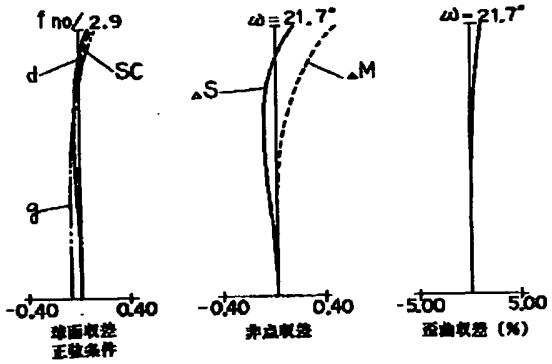
【図6】



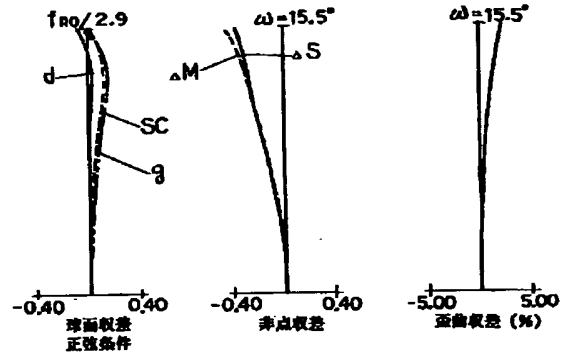
【図7】



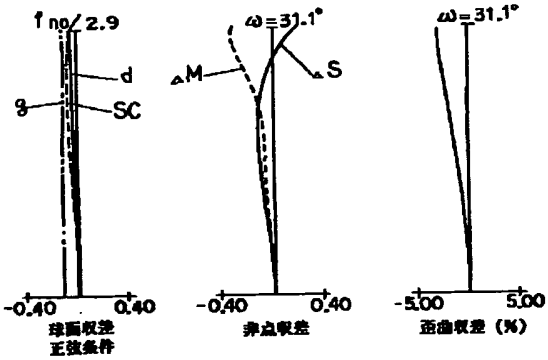
【図8】



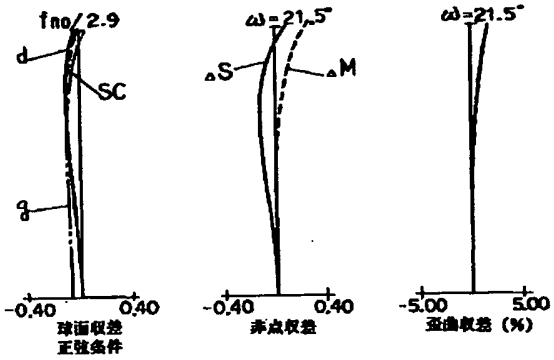
【図9】



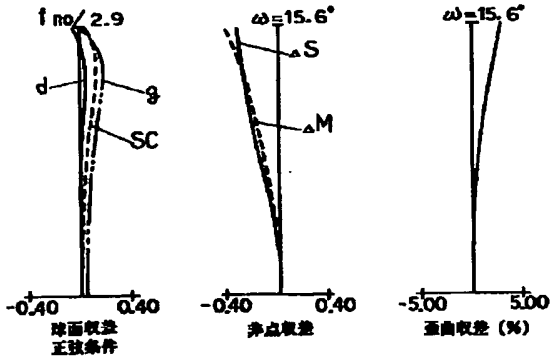
【図10】



【図11】



【図12】


f no/2.9
d
g
SC
-0.40
0.40
球面収差
正弦条件
ω=15.6°
S
M
-0.40
0.40
非点収差
ω=15.6°
-5.00
5.00
歪曲収差（%）

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the suitable zoom lens for the camera for photographs for 35mm films, a video camera, simian-virus camera for electronic recording, etc. It has five lens groups as the whole which the lens group of negative refractive power precedes especially. It is related with the zoom lens which includes an extensive field angle region with high optical-character ability over all variable power ranges by setting up appropriately refractive power, lens composition, etc. of move conditions or each lens group accompanying the variable power of these five lens groups.
[0002]
[Description of the Prior Art] Since the formation of an extensive field angle is comparatively easy, many so-called negative lead type zoom lenses on the zoom lens for extensive field angles which the lens group of negative refractive power precedes from before are used. For example, the 1st group of refractive power more negative than a body side to order with JP,49-23912,B or JP,57-163213,A, The zoom lens to which it has four lens groups of the 2nd group of positive refractive power, the 3rd group of negative refractive power, and the 4th group of positive refractive power, the 1st group was moved to the image surface side on the occasion of the variable power from a wide angle edge to a tele edge, the 2nd group and the 4th group were moved to the body side, and the 3rd group was fixed or moved is proposed.
[0003] The formation of an extensive field angle is comparatively easy for the negative lead type zoom lens which the lens group of such negative refractive power precedes, and it has the features, like contiguity photography distance becomes short.
[0004] However, if the refractive power of each lens group is strengthened attaining high variable power-ization in order to attain the miniaturization of the whole lens system, generating of many aberration will increase and optical-character ability will deteriorate greatly. Moreover, it extracts that it is going to attain diameter-ization of macrostomia, a path increases, and the trouble that the whole lens system is enlarged arises.
[0005] These faults are improved and the zoom lens which attained miniaturization of the whole lens system and high variable power-ization is proposed for example, in JP,55-14403,B, the JP,63-241511,A publication-number No. 193709 [one to] official report, etc.
[0006] In each of these official reports, a zoom lens is constituted from a body side in order [groups / lens / four] as the whole lens group of negative, positive, and negative and positive refractive power, among these a predetermined lens group is moved appropriately, and variable power is performed.
[0007] In addition, in JP,2-201310,A, the zoom lens which made easy focal operation at the time of moving some [comparatively lightweight] lens groups in the 1st group on an optical axis in the zoom lens of the same composition, and performing a focus, for example, performing auto-focusing is proposed.
[0008]
[Problem(s) to be Solved by the Invention] The thing of a high variable power ratio is demanded in recent years as a zoom lens for standards used for a single-lens reflex camera, a video camera, etc., including an extensive field angle. For example, with the single-lens reflex camera for 35mm films, the zoom lens of an extensive field angle with a focal distance of 35mm - about 70mm is already used as a zoom lens for standards.
[0009] If it is generally going to secure an about 2.8-f number aperture ratio moreover with a

photography field angle of this level, lens composition will become complicated and an amendment's will become difficult good about optical-character ability over all variable power ranges. Moreover, generally with such a zoom lens, the lens outer diameter of the 1st group by the side of a body is a quantity weight in many cases greatly again.

[0010] For this reason, auto-focusing etc. is electric, and when Shigekazu Taka's 1st group is moved on the occasion of a focus, driving means, such as a large-sized motor, are needed, and with the camera of the power focus method which performs a focus, there is a trouble that the whole camera is enlarged in respect of power consumption, a space, etc.

[0011] By constituting a zoom lens from five lens groups as a whole, and setting up appropriately the move conditions of each lens group in accordance with the refractive power and variable power of each lens group etc., this invention shortens a lens overall length and, moreover, aims [by the diameter ratio of macrostomia] at offer of a zoom lens with high optical-character ability over all variable power ranges with an extensive field angle comparatively.

[0012] In addition, in this invention, by lens groups other than the 1st group, the inner focus method which performs a focus is adopted and focal operation aims at offer of the zoom lens of the suitable extensive field angle for a plain-gauze cone, for example, an auto-focus camera etc.

[0013]

[Means for Solving the Problem] The 1st group of refractive power more negative than a body side to order in the zoom lens of this invention, the 2nd group of negative refractive power, It has five lens groups of the 3rd group of positive refractive power, the 4th group of negative refractive power, and the 5th group of positive refractive power. On the occasion of the variable power from a wide angle edge to a tele edge, the interval of this 2nd group and the 3rd group is decreased. the interval of this 3rd group and the 4th group is increased, and the interval of this 4th group and the 5th group is decreased -- as -- at least -- this -- while moving the 1st, the 2nd, the 3rd, and the 5th group, it is characterized by moving this 1st group and the 2nd group by different tracing

[0014] In this invention, the 1st group is characterized by moving moving to ** on the other hand especially on the occasion of variable power, and the 2nd group, and performing the focus etc.

[0015]

[Example] Drawing 1 - drawing 3 are the lens cross sections in the wide angle edge of the numerical examples 1-3 of this invention.

[0016] For the inside L1 of drawing, the 1st group of negative refractive power, the 2nd group of refractive power negative in L2, the 3rd group of refractive power positive in L3, the 4th group of refractive power negative in L4, and L5 are the 5th group of positive refractive power. SP is drawing. The arrow shows the move locus of each lens group at the time of performing variable power from a wide angle edge to a tele edge.

[0017] At this example, as shown in drawing, the interval of the 2nd group and the 3rd group is decreased on the occasion of the variable power from a wide angle edge to a tele edge, the interval of the 3rd group and the 4th group is increased, and while moving a predetermined lens group so that the interval of the 4th group and the 5th group may be decreased, the 1st group and the 2nd group are moved by mutually different locus.

[0018] Among these, all five lens groups are moved in the numerical example 1 of drawing 1 . In drawing 2 and the numerical examples 2 and 3 of drawing 3 , the 1st, the 2nd, the 3rd, and the 5th group are moved, and the 4th group is considered as fixation. Moreover, in each example of drawing 1 - drawing 3 , a focus moves the 2nd group and is performed.

[0019] In a wide angle edge, the 3rd group of positive refractive power was separated on the optical axis, and the zoom lens of this invention has both, arranged it to the 1st negative group and the 2nd negative group of refractive power, (detaching distantly), has approached and arranged the 4th group of negative refractive power to **** 3 group, and separates and arranges the 5th group of positive refractive power to the 4th group further. The predetermined back focus is made to be obtained easily, attaining extensive field angle-ization by this, as the whole lens system serves as retrospective type lens composition.

[0020] And it is made for the 3rd group of positive refractive power to both approach to the 1st negative group and the 2nd negative group of refractive power in a tele edge on the occasion of the variable power from a wide angle edge to a tele edge. It is made for the interval of the 3rd group and the 4th group of negative refractive power to become large, and a predetermined lens group is moved, variable power is performed, and it is made for the whole lens system to serve as overlooked-a distant view type

(teletype) lens composition so that the 5th group of positive refractive power may approach to the 4th group.

[0021] Variable power is made by this to share with each lens group effectively, the movement magnitude of each lens group in the case of variable power is decreased, and the miniaturization of the whole lens system is attained, securing a predetermined variable power ratio.

[0022] In the numerical example 1 of drawing 1 , on the occasion of the variable power from a wide angle edge to a tele edge, the 1st group and the 4th group are linearly moved to an image surface side, the 3rd group is linearly moved to a body side, the 5th group is moved so that it may have a convex locus to a body side, and the 2nd group is moved so that it may have a convex locus to an image surface side. In addition, in drawing 2 and the numerical examples 2 and 3 of drawing 3 , the 4th group is fixation, the 5th group moves to a body side linearly, and other lens groups are the same as the numerical example 1.

[0023] In this invention, at this time, the 1st group is enabling composition of a strong lens barrel to the shock to the direction of an optical axis of a camera, as traverse speed changes rapidly or the move direction is not reversed in the middle of variable power on the occasion of variable power.

[0024] While moving especially the 1st group linearly and strengthening to the shock to a camera, a lens barrel structure top also makes a cam groove unnecessary, and simplification of lens barrel structure is attained. Moreover, by using the so-called inner focus method which is made to move the 2nd group with a comparatively light lens weight on an optical axis, and performs a focus, focal operation when applying to for example, an OTOFU focus camera is made easy, and high-speed focal operation is enabled.

[0025] Furthermore, by adopting such an inner focus method, structure of the lens barrel which the 1st group does not rotate in the case of variable power and a focus is made possible, and constitutional simplification is made easy.

[0026] It constitutes from a zoom lens of this invention so that it may have the meniscus-like negative lens which turned the concave surface of refractive power strong against an image surface side to the 1st group. The axial outdoor daylight bunch was made refracted gradually by this, retrospective mold-ization of the whole lens system was made easy in the wide angle edge, and the negative distortion aberration by the side of the wide angle generated when extensive field angle-ization is attained is rectified good.

[0027] In addition, it is good to satisfy the following terms and conditions for aberration change to obtain few high optical-character ability over all variable power ranges, attaining shortening and the formation of an extensive field angle of a lens overall length in this invention.

[0028] The 2nd group of the above has the 21st negative lens which turned the concave surface to the image surface side, and the 22nd positive lens which turned the convex to the body side. The radius of curvature of the lens side by the side of the body of R2a and this 22nd lens for the radius of curvature of the lens side by the side of the image surface of this 21st lens R2b, the focal distance of composition of the 1st group [in / fi and a wide angle edge / for the focal distance of the i-th group of the above] of the above, and the 2nd group -- f -- time of setting the focal distance of the whole system in 1, 2, and a tele edge to fT 0.35< -- |f1 and 2|/fT<0.9 ..... (1)

0.75<f1/f2<3.0 ..... (2)

0.7 <R2 A/R2B<1.2 ..... (3)

It is satisfying the becoming conditions.

[0029] It is the thing of an amendment sake with sufficient BARANSUKU about many aberration, conditional expression (1) setting up appropriately the refractive power of composition of the 1st group in a wide angle edge, and the 2nd group, and mainly attaining reduction-ization of a lens outer diameter.

[0030] If the refractive power of composition of the 1st group and the 2nd group becomes weak too much exceeding the upper limit of conditional expression (1), in order that a refraction operation of an axial outdoor daylight bunch may become weak and may secure the axial outdoor daylight bunch of the specified quantity to a wide angle side, you have to enlarge the lens outer diameter of the 1st group and the 2nd group. Moreover, if the refractive power of composition of the 1st group and the 2nd group becomes strong too much exceeding a lower limit, although the lens outer diameter of the 1st group and the 2nd group becomes small, aberration outside a shaft, such as distortion aberration generated by the 1st group and the 2nd group and astigmatism, will become large, and an amendment's will become difficult by other lens groups about many of such aberration.

[0031] It is a thing for lessening aberration change at the time of carrying out a focus by the 2nd group,

conditional expression (2) setting up appropriately the ratio of the refractive power of the 1st group and the 2nd group by the basis of conditional expression (1), and mainly attaining shortening of a lens overall length.

[0032] Although the movement magnitude when carrying out a focus by the 2nd group becomes small and it is advantageous to shortening of a lens overall length if the refractive power of the 2nd group becomes strong too much exceeding the upper limit of conditional expression (2), the amount of aberration change in the case of a focus becomes large, and it becomes difficult to keep optical-character ability good over the object distance at large. Moreover, since the lens outer diameter of the 1st group for the interval of the 1st group and drawing becoming long and securing an axial outdoor daylight bunch will increase while the movement magnitude in the case of a focus increases and a lens overall length becomes long if the refractive power of the 2nd group becomes weak too much exceeding a lower limit, it is not good.

[0033] Conditional expression (3) is the thing of an amendment sake good about the spherical aberration which sets up appropriately the ratio of the radius of curvature Ra of the lens side by the side of the image surface of the 21st negative lens which constitutes the 2nd group, and the radius of curvature Rb of the lens side by the side of the body of the 22nd positive lens, and is mainly generated by the 1st group.

[0034] If radius-of-curvature R2a becomes large too much compared with radius-of-curvature R2b exceeding the upper limit of conditional expression (3), although spherical aberration is rectified good, the negative refractive power of the 2nd whole group will become weaker, and if this is paid in respect of other lenses, the yield of many aberration, such as comatic aberration, will increase more than this lens side.

[0035] Moreover, if radius-of-curvature R2a becomes small too much compared with radius-of-curvature R2b exceeding a lower limit, the yield of positive spherical aberration will increase and an amendment's will become difficult in respect of other lenses about this in respect of the lens by the side of the body of for example, the 22nd lens.

[0036] In addition, it is good to satisfy the following conditions with sufficient balance [aberration / many] for an amendment over all variable power ranges, securing a predetermined variable power ratio in this invention.

[0037] When the 3rd group of the above has the negative lens of at least one sheet, and the positive lens of at least two sheets and the focal distance of the whole system [in / f3 and a tele edge / for the focal distance of this 3rd group] is set to fT $0.28<f3/fT<0.85$ ..... (4)

It is satisfying the becoming conditions.

[0038] Conditional expression (4) is related with the ratio of the focal distance of the 3rd group to the focal distance of the whole system in a tele edge.

[0039] Since the movement magnitude of each lens group in accordance with the variable power for securing a predetermined variable power ratio increases, and a lens outer diameter will also increase while a lens overall length becomes long if the refractive power of the 3rd group becomes weak too much exceeding the upper limit of conditional expression (4), it is not good. Moreover, if the refractive power of the 3rd group becomes strong too much exceeding a lower limit, although the whole lens system becomes small, generating of many aberration, such as spherical aberration, will increase from the 3rd group, and an amendment's will become difficult by other lens groups about this.

[0040] While it is satisfied [with this invention] of conditional expression (4), the 3rd group is constituted so that it may have the negative lens of at least one sheet, and the positive lens of at least two sheets, and thereby, the yield of spherical aberration is lessened for chromatic aberration with the amendment good.

[0041] Next, the numerical example of this invention is shown. a numerical example -- setting -- Ri -- a body side -- the i-th lens ** and an air interval, nickel, and nui are the radius of curvatures of the i-th lens side, and Di is the refractive index and the Abbe number of glass of the i-th lens in order from an each body side in a body side

[0042] It is [0043], when the aspheric surface configuration made travelling direction of H shaft and light positive to the X-axis, the optical axis, and the perpendicular direction in the direction of an optical axis, and R is made into paraxial radius of curvature and it makes A, B, C, D, and E an aspheric surface coefficient respectively.

[Equation 1]

$$X = \frac{(1/R)H^2}{1+\sqrt{1-(H/R)^2}} + AH^2 + BH^4 + CH^6 + DH^8 + EH^{10}$$

It expresses with the becoming formula. Moreover, the relation between each above-mentioned conditional expression and many numeric values in a numerical example is shown in Table -1. Numerical example 1 F= 36.5-77.4 FNO=1:2.9 2omega= 62.2 degree-31.1 degree R 1= 69.33 D 1= 2.20 N 1=1.77250 nu 1= 49.6 (Aspheric surface) R 2= 38.49 D 2= Adjustable R 3= -79.11 D 3= 1.80 N 2=1.88300 nu 2= 40.8 R 4= 54.47 D 4= 0.50 R 5= 56.11 D 5= 4.50 N 3=1.84666 nu 3= 23.8 R 6= 5045.30 D 6= Adjustable R 7= 89.26 D 7= 1.50 N 4=1.84666 nu 4= 23.8 R 8= 37.81 D 8= 8.00 N 5=1.65160 nu 5= 58.5 R 9=-103.33 D 9= 0.15 R10= 74.97 D10= 4.00 N 6=1.69680 nu 6= 55.5 R11= 1307.60 D11= 0.15 R12= 51.67 D12= 5.00N 7=1.69680 nu 7= 55.5 R13= 3317.12 D13= Adjustable R14= (drawing) D14= 2.00 R15= -93.73 D15=3.30 N 8=1.80518 nu 8= 25.4 R16= -31.23 D16= 1.30 N 9=1.63930 nu 9= 44.9 R17= 77.19D17= 1.40 R18=-162.57 D18= 1.30 N10=1.60323 nu10= 42.3 R19=-7621.93 The D19= adjustable R20= 245.95 D20= 1.30 N11=1.84666 nu11= 23.8 R21= 35.85 D21= 2.70 R22= 871.81 D22= 3.00 N12=1.69680 nu12= 55.5 R23=-46.11 D23= 0.15 R24= 41.75 D24= 2.80 N13=1.77250 nu13= 49.6 R25= 81.22 The number of aspheric surface systems B= 2.01734x10-7 C= 1.45657x10-10 D= 6.76429x10-14 E=-3.01424x10-16 [0044]

[Table 1]

焦点距離 可変間隔	36.52	77.42
D 2	16.43	15.33
D 6	37.63	0.99
D13	2.64	19.64
D19	18.93	1.93

Numerical example 2 F= 35.9-77.8 FNO=1:2.9 2omega= 62.2 degree-31.1 degree R 1= 684.66 D 1= 2.62 N 1=1.80518 nu 1= 25.4 R 2=-1055.76 D 2= 0.20 R 3= 149.76 D 3= 2.10 N 2=1.71300 nu 2= 53.8 R 4= 53.30 D 4= Adjustable R 5=-488.25 D 5= 2.00 N 3=1.77250 nu 3= 49.6 R 6= 44.81 D 6= 0.53 R 7= 43.27 D 7= 3.50 N 4=1.84666 nu 4= 23.9 R 8= 78.34 D 8= Adjustable R 9= 84.43 D 9= 1.20 N 5=1.84666 nu 5= 23.8 R10= 30.98 D10= 7.20 N 6=1.55963 nu 6= 61.2 R11=-1529.08 D11= 0.15R12= 50.67 D12= 6.00 N 7=1.65160 nu 7= 58.5 R13=-110.42 D13= 0.15 R14= 40.57 D14= 3.30 N 8=1.65160 nu 8= 58.5 R15= 71.98 D15= Adjustable R16= (drawing) D16= 1.50 R17=-145.10 D17= 3.00 N 9=1.84666 nu 9= 23.8 R18= -34.13 D18= 1.20 N10=1.60311 nu10= 60.7 R19= 112.83 D19= 2.00 R20= -42.83 D20= 1.40 N11=1.60311 nu11= 60.7 R21= 66.44 D21= Adjustable R22= 347.07 D22= 5.00 N12=1.55963 nu12= 61.2 R23= -26.27D23= 1.50 N13=1.80518 nu13= 25.4 R24= -35.22 D24= 0.15 R25= 104.39 D25= 5.00 N14=1.71300 nu14= 53.8 R26= -51.25 D26= 5.44 R27= -30.94 D27= 1.35 N15=1.84666 nu15= 23.8 R28= -84.63 [Table 2]

焦点距離 可変間隔	35.91	77.79
D 4	18.02	17.94
D 8	40.13	2.52
D15	6.91	21.23
D21	13.17	2.94

Numerical example 3 F= 35.8-77.6 FNO=1:2.9 2omega= 62.3 degree-31.2 degree R 1= 791.76 D 1= 2.62 N 1=1.80518 nu 1= 25.4 R 2 -1937.16 D 2= 0.20 R 3= 112.86 D 3= 2.10 N 2=1.71300 nu 2= 53.8

R 4= 51.40 D 4= Adjustable R 5= -317.21 D 5= 2.00 N 3=1.77250 nu 3= 49.6 R 6= 44.52 D 6= 0.60 R 7= 43.29 D 7= 3.50 N 4=1.84666 nu 4= 23.9 R 8= 75.72 D 8= Adjustable R 9= 78.89 D 9= 1.20 N 5=1.84666 nu5= 23.8R10= 31.34 D10= 7.20 N 6=1.55963 nu 6= 61.2 R11=-78204.10 D11= 0.15 R12= 52.30 D12= 6.00 N 7=1.65160 nu 7= 58.5 R13= -104.66 D13= 0.15 R14= 43.06 D14= 3.30 N 8=1.65160 nu 8= 58.5 R15= 95.40 D15= Adjustable R16= (drawing) D16= 1.50 R17= -134.01 D17= 3.00 N 9=1.84666 nu 9= 23.8 R18= -33.45 D18= 1.20 N10=1.60311 nu10= 60.7 R19=102.01 D19= 2.00 R20= -44.08 D20= 1.40 N11=1.60311 nu11= 60.7 R21= 63.77 D21= Adjustable R22= 723.38 D22= 5.30 N12=1.55963 nu12= 61.2 R23= -26.94 D23= 1.50 N13=1.80518 nu13= 25.4 R24= -31.98 D24= 0.15 R25= 97.49 D25=5.00 N14=1.71300 nu14= 53.8 R26= -48.30 D26= 2.50 R27= -32.10 D27= 1.35 N15=1.84666 nu15= 23.8 R28= -125.97 [Table 3]

焦点距離 可変間隔	35.80	54.93	77.64
D 4	18.26	22.67	17.75
D 8	39.45	13.78	2.44
D15	7.07	14.07	21.07
D21	13.17	8.09	3.01

[0045]
[Table 4]

表 － 1

条 件 式	数 値 実 施 例		
	1	2	3
(1) | f 1, 2 | ／ f T	0.576	0.897	0.693
(2) f 1／f 2	1.418	1.522	1.897
(3) R 2 a／R 2 b	0.971	1.036	1.028
(4) f 3／f T	0.413	0.483	0.461

[0046]
[Effect of the Invention] Moreover, a zoom lens with high optical-character ability can be comparatively attained over all the variable power ranges of a high variable power ratio with an extensive field angle, shortening a lens overall length and making lens barrel structure simple by specifying the move conditions of each lens group followed on the refractive power and variable power of five lens groups like the above-mentioned etc., according to this invention.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The lens cross section of the numerical example 1 of this invention
[Drawing 2] The lens cross section of the numerical example 2 of this invention
[Drawing 3] The lens cross section of the numerical example 3 of this invention
[Drawing 4] Many aberration views in the zoom position of the wide angle edge of the numerical example 1 of this invention
[Drawing 5] Many aberration views in the middle zoom position of the numerical example 1 of this invention
[Drawing 6] Many aberration views in the zoom position of the tele edge of the numerical example 1 of this invention
[Drawing 7] Many aberration views in the zoom position of the wide angle edge of the numerical example 2 of this invention
[Drawing 8] Many aberration views in the middle zoom position of the numerical example 2 of this invention
[Drawing 9] Many aberration views in the zoom position of the tele edge of the numerical example 2 of this invention
[Drawing 10] Many aberration views in the zoom position of the wide angle edge of the numerical example 3 of this invention
[Drawing 11] Many aberration views in the middle zoom position of the numerical example 3 of this invention
[Drawing 12] Many aberration views in the zoom position of the tele edge of the numerical example 3 of this invention
[Description of Notations]
L1 The 1st group
L2 The 2nd group
L3 The 3rd group
L4 The 4th group
L5 The 5th group
SP Drawing
S Sagittal image surface
M Meridional image surface
d d line
g g line

[Translation done.]

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The 1st group of refractive power more negative than a body side to order, the 2nd group of negative refractive power, the 3rd group of positive refractive power, It has five lens groups of the 4th group of negative refractive power, and the 5th group of positive refractive power. On the occasion of the variable power from a wide angle edge to a tele edge, the interval of this 2nd group and the 3rd group is decreased. the interval of this 3rd group and the 4th group is increased, and the interval of this 4th group and the 5th group is decreased -- as -- at least -- this -- the zoom lens characterized by moving this 1st group and the 2nd group by different tracing while moving the 1st, the 2nd, the 3rd, and the 5th group
[Claim 2] The 1st group of the above is the zoom lens of the claim 1 characterized by on the other hand moving to ** on the occasion of variable power.
[Claim 3] The zoom lens of the claim 1 characterized by moving the 2nd group of the above and performing the focus.
[Claim 4] The 2nd group of the above has the 21st negative lens which turned the concave surface to the image surface side, and the 22nd positive lens which turned the convex to the body side. The radius of curvature of the lens side by the side of the body of R2a and this 22nd lens for the radius of curvature of the lens side by the side of the image surface of this 21st lens R2b, The focal distance of the i-th group of the above fi, the focal distance of composition of the 1st group of the above in a wide angle edge, and the 2nd group -- f, when the focal distance of the whole system in 1, 2, and a tele edge is set to fT 0.35<|f1, 2|/fT<0.90.75<f1/f2<3.00.7 Zoom lens of the claim 1 characterized by satisfying the conditions which become <R2 a/R2b<1.2.
[Claim 5] The 3rd group of the above is the zoom lens of the claim 1 characterized by satisfying the becoming conditions 0.28<f3-/fT<0.85, when it has the negative lens of at least one sheet, and the positive lens of at least two sheets and the focal distance of the whole system [in / f3 and a tele edge / for the focal distance of this 3rd group] is set to fT.

[Translation done.]